

Reference Manual

The Complete Blood Test (CBC)

The complete blood test (CBC) is a screening test used to diagnose and manage many diseases. The test can reveal problems with red blood cell production and destruction, or help diagnose infection, allergies, and problems with blood clotting or fluid volume. It is actually several tests that examine different parts of the blood, including:

- Red blood cell (RBC) count is a count of the number of red blood cells per volume of blood.
- White blood cell (WBC) count is a count of the number of white blood cells per volume of blood.
- Hemoglobin measures the amount of oxygen-carrying protein in the blood.
- Hematocrit measures the percentage of red blood cells in a given volume of whole blood.
- Mean corpuscular volume (MCV) is a measurement of the average size of your RBCs. The MCV is elevated when your RBCs are larger than normal (macrocytic), and decreased when the RBCs are smaller than normal (microcytic).
- MCV:RBC ratio is obtained by dividing the mean corpuscular volume (MCV) by the red blood cell count.
- Red blood cell distribution width (RDW) is a measure of variation in RBC width. Normally, red blood cells are fairly uniform in size and shape. In some diseases, a given blood sample may have a high RDW meaning that there is a great deal of variation in the size of the red blood cells in the sample.
- Total Iron Binding Capacity (TIBC) shows if there is too much or too little iron in the blood.
- The serum ferritin concentration indicates the body's stores of iron.

Appearance of Normal RBCs

In a normal blood sample prepared for viewing under the microscope, the RBCs are 7–8 micrometers in diameter. They are very similar in size to each other and have a smooth surface. RBCs are usually fairly dark red, (However, because of their flattened shape, the center of the cell may look lighter when viewed in the microscope. RBCs do not have a nucleus. WBCs are often larger than RBCs and have nuclei that are irregular in shape and darkly stained.

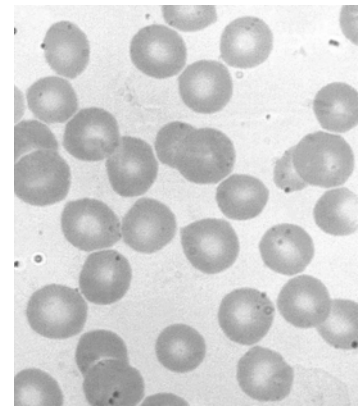


Image credit: CDC/Dr. Mae Melvin

Disease: Alpha-thalassemia

Brief Description: Alpha-thalassemia refers to a disease characterized by reduced or no production of the alpha globin proteins that form hemoglobin. Alpha-thalassemia is a condition in which a person produces less or no alpha globin protein.

Cause: Alpha-thalassemia is caused by changes in the alpha globin genes on chromosome 16.

Diagnosis:

Doctors usually use blood tests to diagnose alpha-thalassemia. Because it is an inherited disease, they will also check family history. In some cases, DNA testing may be used. Thalassemia affects both males and females.

Appearance of RBCs: In patients with alpha-thalassemia, red blood cells are often smaller than normal (microcytosis; normal red blood cells are 7-8 micrometers in diameter). The size of the red blood cells usually relates to the type of alpha-thalassemia that the individual has. If a person is a silent carrier of the disease, the red blood cells may only be slightly smaller than normal. As the disease gets more severe, the red blood cells are significantly smaller than normal.

The **MCV:RBC ratio** is a way to distinguish thalassemia from other kinds of anemia. In individuals with alpha-thalassemia, the MCV:RBC ratio is less than 13. In iron deficiency anemia, the ratio is above 13.

The **hematocrit** (percentage of blood taken up by red blood cells) is usually increased in alpha-thalassemia carriers or people with alpha-thalassemia trait.

The **total iron binding capacity (TIBC)** is usually normal in thalassemia.

The **red blood cell distribution width (RDW)** value is normal in thalassemia. The red blood cells in a sample from a thalassemia patient may be somewhat smaller than normal, but they are similar in size to the other cells in the sample.

Blood Test Data	Alpha-thalassemia	Comparison with normal values
Hemoglobin concentration (Hb,g/dL)	9.9-15.7	Lower in person with thalassemia
Mean corpuscular volume (MCV; fL)	59.0-88.1	Lower in person with thalassemia
Red blood cell (RBC) appearance	may be smaller in diameter than normal; may vary more in size and shape than normal; may be lighter in color than normal	Normal red blood cells are dark red and uniform in size and shape

Terminology and abbreviations:

- Mean corpuscular volume (MCV) is the average volume contained in a red blood cell. In other words, MCV is an estimate of cell size.
- Mean corpuscular hemoglobin (MCH) is the average amount of hemoglobin contained in a red blood cell.
- Deciliter (dL) is a unit of volume equivalent to one-tenth of a liter or 100 milliliters.
- Milliliter (mL) is a unit of volume equivalent to 10^{-3} liter (1 one-thousandth of a liter).
- Microliter (μL) is a unit of volume equivalent to 10^{-6} liter (one millionth of a liter).
- Femtoliter is a unit of volume equivalent to 10^{-15} liter (1 one-quadrillionth of a liter).
- Nanogram is a unit of mass equal to 10^{-9} grams.
- Picogram is a unit of mass equal to 10^{-12} grams (1 one-trillionth of a gram).

Symptoms:

Symptoms of alpha-thalassemia range from no symptoms or mild symptoms to severe. One form of alpha-thalassemia is almost always fatal. In general, the severity of the symptoms correlate with the number of nonfunctional alpha-globin genes that a person has.

Disease: Sickle cell disease

Brief Description: Sickle cell disease is an inherited form of anemia. Similar to other types of anemia, in sickle cell disease there aren't enough healthy red blood cells to carry adequate oxygen to all the cells of the body.

Cause: Sickle cell anemia is a genetic disease caused by an abnormal type of hemoglobin called hemoglobin S. Hemoglobin S distorts the shape of red blood cells, especially when oxygen levels are low.

The red blood cells in someone who has sickle cell disease are distorted. Instead of the smooth, circular biconcave shape of normal red blood cells, a proportion of the red blood cells in sickle cell disease are shaped like crescents. They can clog in the small blood vessels.

Diagnosis:

Sickle cell disease is diagnosed with a blood test. The blood test will determine whether a person has normal or sickle hemoglobin.

Appearance of RBCs: In sickle cell disease, a proportion of a person's red blood cells will have a characteristic shape that can be observed under a microscope. Sickle cells are crescent-shaped—or shaped like the tool called a sickle.

In an individual with sickle cell disease,

- the **total iron binding capacity (TIBC)** measurement is below normal.
- the **white blood cell (WBC) count** is usually somewhat high.

Symptoms:

Sickle cells are destroyed rapidly in the body of people with the disease causing anemia, jaundice, and gallstones.

The sickle cells also block the flow of blood through vessels resulting in lung tissue damage, pain episodes, or stroke. It also causes damage to most organs including the spleen, kidneys and liver. Damage to the spleen makes sickle cell disease patients, especially young children, easily overwhelmed by certain bacterial infections.

Symptoms may include:

- Attacks of abdominal pain
- Bone pain
- Delayed growth and puberty
- Jaundice
- Rapid heart rate
- Chest pain
- Poor eyesight/blindness
- Strokes
- Skin ulcers

Disease: Iron deficiency anemia

Brief Description: Iron deficiency anemia is a common type of anemia — a condition in which blood lacks adequate healthy red blood cells. Red blood cells carry oxygen to the body's tissues.

Cause: Normally, a person gets iron from the food he or she eats. In addition, iron can be recycled from old red blood cells. Iron deficiency anemia occurs if a person doesn't consume enough iron in the diet, doesn't produce enough of the iron-containing hemoglobin, or if a person loses too much iron, which occurs most commonly through blood loss.

Diagnosis: Doctors use blood tests to diagnose iron deficiency anemia. Indications of iron deficiency anemia include

Abnormal red blood cells. The red blood cells in someone with iron deficiency anemia are smaller than normal (microcytosis; normal RBCs are 7-8 micrometers in diameter) and paler in color than normal (hypochromia). The red blood cells also may be irregular in size and shape (RBCs within a sample may have different sizes and not be as smooth and round as normal RBCs)

Hemoglobin levels. Hemoglobin levels in someone with iron deficiency anemia are lower than normal.

Hematocrit: In a person who has iron deficiency anemia, the hematocrit readings are below normal.

Ferritin concentration in serum: At times, it may be hard to distinguish between iron-deficiency anemia and thalassemia. The serum ferritin concentration is one way that doctors can determine whether a person has alpha-thalassemia or iron deficiency anemia. Iron deficiency anemia is diagnosed when a person's **serum ferritin concentration** is less than 12 ng/mL.

Also, in iron-deficiency anemia,

- The **MCV:RBC ratio** is greater than 13.
- the **RDW** is high indicating a larger variation in size of the red blood cells.
- the **TIBC** measurement is above normal.

Symptoms: In mild cases, a person who has iron deficiency anemia may not have any noticeable symptoms. As the deficiency becomes more serious, a person may notice symptoms including

- Extreme fatigue
- Irregular heartbeat
- Pale skin
- Shortness of breath
- Dizziness
- Weakness
- Increased number of infections
- Headaches